CITY OF TORONTO. JOINT ELECTRICAL ENERGY PLANNING COMMITTEE

INTERIM REPORT

Aug.18,1983

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CITY OF TORONTO
JOINT ELECTRICAL ENERGY PLANNING COMMITTEE

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August 18, 1983

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Municipal Reference

To: City Services Committee, Toronto Electric Commissioners and Ontario Hydro.

Subject: Interim Report.

Origin: Joint Electrical Energy Planning Committee (c71csc83040:109)

Background:

In May 1982 City Council and the Toronto Electric Commissioners approved Terms of Reference for a long run joint study of electric demand in the City (the Joint Electrical Energy Planning Study - JEEP). The need for such a study was originally identified during discussions about the proposed expansion of the Cecil Transformer Station in 1981. At that time the suggested study was concerned with only the Central Area but subsequent discussions led to the conclusion that the entire City should be included. The study group includes representatives from Ontario Hydro, Toronto Hydro and the Public Works and Planning and Development Departments. The purpose of the study is to examine the demand for electricity over the medium (5-10 years) and long term (10-15 years) and to recommend the most appropriate means of augmenting the existing bulk power system to meet the projected demand.

The Committee started meeting in July 1982 and established that forecasting would be undertaken for fairly large districts incorporating groups of transformer and switching stations. The Committee met on a fairly regular basis throughout the fall of 1982 and into the early spring of 1983. The meetings have been open to the public, and Energy Probe has had a representative at every meeting who has often contributed to the discussion. In addition, a number of resident groups and interested individuals have requested to be placed on a mailing list and can contact the Committee Secretary for copies of any material tabled.

Initiatives of the Committee

Since the Downtown Core has experienced the most rapid growth in electric demand, and could pose problems in the future with significant construction in the Railway Lands and Harbourfront, the Committee focussed attention on this area (the South-Central Service Area).

A forecast had been prepared by staff of Toronto Hydro and Ontario Hydro which concluded that a new transformer station would be

required in this area between 1989 and 1995. The JEEP Committee established a load forecast task group with a mandate to review the given forecast and explore forecasting methodology in general.

An attempt was made to determine the degree to which electrical demand is correlated with the construction of new floor area. This was seen as being particularly relevant for the Core Area. While there appears to be some correlation between the rate of growth of office space and overall electrical demand, forecasting is limited by the data available to match floor space with hydro consumption and by the extent to which growth in floor space can be projected. While it is possible for City staff to estimate office space growth in the Core with reasonable accuracy, it is much more difficult to predict medium and long run growth for other land uses, particularly outside the high growth area downtown.

Notwithstanding these limitations, some fairly significant benefits came out of the forecasting attempt:

- As part of the process of preparing a Scope of Study Document required to initiate an Environmental Assessment, a review of the original forecast led Toronto Hydro and Ontario Hydro to conclude that new transformer facilities would not be required in the South-Central area as early as anticipated. The drafting of a Scope of Study Document has therefore been postponed. The primary reason for the deferral was a decision to make use of larger transformers at existing stations if necessary or desirable. Since the downtown core can quickly use up existing spare capacity and advance the requirement for a new transformer station, the situation must be monitored. Toronto Hydro's annual reviews of current and proposed loadings in the South Central area will allow a timely decision when and if it is necessary to re-institute the study.

- Since the land use development projection showed that future growth over the long term will be concentrated in the Railway Lands and Harbourfront, Toronto Hydro is exploring the possibility of having a parcel of land set aside within the Railway Lands for a transformer/switching station site if and as required.

- It was recognized that the database maintained by the Planning and Development Department was of considerable benefit in enhancing the current forecasting data of Toronto Hydro. The resolution of problems encountered in matching records between this database and that of Toronto Hydro will be beneficial to any future forecasting efforts. City and Toronto Hydro staff

are currently exploring the possibility of database reconcilation as a basis for future forecasting.

Conclusions

It appears that the JEEP Study has provided a useful forum for exploring new methods of forecasting electrical demand. It has also been a useful forum for the exchange of information and the co-ordination of planning efforts. This inter-agency link has also been of some use in bringing parties together. For example, staff from Ontario Hydro and the Harbourfront Corporation were brought together to discuss the future of the Hydro property at 230 Queen's Quay West. Also, Toronto Hydro took advantage of a Committee meeting to explain a new program for replacing overhead wes in residential areas.

Future Work

In the coming months, the JEEP Committee is proposing to:

- continue meeting as a forum for the exchange of information between City and Hydro staff;
- explore anticipated electric power demand and future hydro facility needs in other parts of the City;
- review the newly released study by Toronto Hydro entitled "Toronto Hydro Residential Load Growth"; and
- begin the work of reconciling the City's database with that of Toronto Hydro, as a basis for improved electricity demand forecasting.

Recommendation:

That this report be received for information.

Simon B. Chamberlain
Chairman

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Toronto Hydro

Residential Load Growth Study

July, 1983

(c99csc83432:60)

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1. Foreword

In May, 1980, a report was prepared by Toronto Hydro entitled Potential for Electric Heating. At that time, staff had been directed to develop wide ranging scenarios about the effects that an unprecedented increase in electric heating load would have on our 4 kilovolt (kV) overhead distribution system.

The report was the starting point for discussions about planning to meet load growth during a period of extreme uncertainty in the energy field. It was speculative, and intended to consider load growth resulting from possible increases in residential electric heating equipment. The report did reveal the need for further, more extensive research about residential load growth in general, and electric heating in particular.

The following report has been entitled the Residential Load Growth Study. It addresses Toronto Hydro's basic needs to enable the utility to meet total load growth on the residential overhead 4 kV system.

The trend toward increased electrical consumption in the City of Toronto has not abated and as a result, sections of Toronto Hydro's 4 kV overhead distribution system are being upgraded as necessary to ensure a reliable supply of

electricity to our customers. The overhead 4 kV system serves most of the residential neighbourhoods located outside of the downtown core.

The upgrading involves the relief of the existing 4 kV overhead system by shifting load onto a 13.8 kilovolt (kV) overhead system, as required. In light of present economic and energy industry uncertainties, Toronto Hydro has planned to meet load growth with caution and on the basis of necessity. Upgrading is proceeding at strategic locations where demand for electricity has pushed the distribution system to capacity, and in some cases, beyond capacity. This construction has been included in the utility's current capital budget, and is expected to continue as part of future budgets as we adjust to meet demand.

A task force comprised of engineering, accounting, rates and cost and information systems personnel have evaluated present economic and engineering factors affecting Toronto Hydro's plant. The following report summarizes their findings and provides recommendations which will enable Toronto Hydro to continue to provide a reliable supply of electricity to its more than 200,000 customers.

2. Executive Summary -

The predictions in this report are derived from detailed analysis of electrical loads at Toronto Hydro substations supplying neighbourhoods across the city. In addition, Toronto Hydro has conducted extensive surveys of customer attitudes towards electricity and is continuing to monitor changes to usage patterns in both the residential and commercial-industrial sectors (see Appendix page A9). Our information base is further supported by several years of experience with the Toronto Hydro energy conservation program, the Canada Oil Substitution Program, the Alberta-Ottawa oil agreement and the Residential Energy Advisory Program.

In many reports, emphasis has been placed on the comparative price of gas and electricity as the key factor influencing energy consumption at the retail level. This report downplays the effect of that factor somewhat and has assumed that, over the next 10 years, the price of gas (60% efficient) compared to the price of electricity (100% efficient) will remain 10% to 15% lower (see Appendix figure 3). However, if a more pronounced swing in prices occurs to the advantage of one fuel over the other, the predictions could be correspondingly affected.

Using figures from a 1982 survey conducted by Toronto Hydro (see Appendix Page A16) it was calculated that load on the residential distribution system could increase at the rate of 3.5 per cent per year to 1990, due to electric heating activity alone. Based on historical patterns, otner growth would contribute another 1.5% of growth per annum.

However, subsequent to the survey being conducted, the world supply of oil has exceeded demand by a considerable margin with the result that international prices have dropped. Canadian prices for home heating oil are not expected to rise at the rate they have for the past few years. As a result, electric heating conversions over the past year have occurred at a slower rate than had been predicted. The number of residential conversions in 1982 totalled approximately 900 compared to a prediction of 1,000 to 1,500, based on the 1982 survey. In 1983 we expect to see 600 to 700 conversions based on actual totals for the first five months of the year, compared to a prediction of 1,000 to 1,800. This is a further indication that the decision to convert to electric heating is predicated on the relative prices of competing fossil fuels. Therefore, a growth rate of 2% due to electric heating conversions, and 1.5% due to normal factors, are considered to be more reasonable, and at this time Toronto Hydro predicts an overall growth rate of 3.5%, or 163,400 kilovolt amperes(kVA), on the 4 kV overhead system.

Accordingly:

(1) Toronto Hydro, in order to relieve the 4 kV overhead system and to meet future demands, will in general limit the 4 kV system at this time to its present capacity, and load growth will be accommodated on a new 13.8 kV overhead distribution system.

(2) Manpower hiring and training will be continued, and correlated to provide the personnel required to meet the construction work caused by load growth on the distribution network. Contractors should be hired only to meet temporary manpower shortages which may occur.

(3) Surveys of consumer attitudes towards different heating alternatives will be conducted annually to enable Toronto Hydro to keep abreast of changing market and load conditions.

(4) Toronto Hydro will need to meet annual capital requirements in excess of internally generated funds (net income plus depreciation) by debentures arranged through the City.

3. Projected Load Growth

Different load growth rates on the 4 kV system to the year 1994 are included in Appendix figure 1, which shows when the total firm capacity will be reached if load growth occurs at rates of 1 per cent, 3.5 per cent and 5 per cent per year. This information has been provided to illustrate the effects of load growths higher or lower than the 3.5 per cent predicted by Toronto Hydro. It should be noted that several substations (see Appendix figure 2) will reach or surpass their firm capacities sooner than the system as a whole. This is due to the fact that the City of Toronto's total electrical load cannot be evenly distributed across Toronto Hydro's entire system. For instance, if firm capacity is reached at a substation located in the eastern part of the city, load relief can only be provided by distributing demand to adjacent substations. This in turn causes overloading at the adjacent substations. Therefore, Toronto Hydro is adding distribution capacity in problem areas in response to localized residential load growth, in order that supply problems may be avoided.

Toronto Hydro's customer surveys indicate that a load growth on the 4 kV system of 3.5 per cent due to electric heating conversions alone is possible. However, as a result

of changing factors affecting the home energy market, this rate of growth is considered high. Therefore, a more conservative load growth rate of 2 per cent due to electric heating conversions has been assumed. This growth, when coupled with a historical load growth rate of 1.5 per cent caused by other factors than electric heating, results in an annual residential load growth rate prediction of 3.5 per cent.

4. Electric Heating:

The rate at which our load is growing has been affected by an increase in residential electric heating. At the end of 1979, there were approximately 3,000 individually metered residential customers using electricity to meet their total heating requirements. By the end of 1982, this number had increased to 7,200. Appendix figure 2 shows that the increase in load on our 4 kV system between 1981 and 1982 was 5.9%. While demand decreased by 3.9% in 1983, we consider this abnormal and caused by an unusually mild winter. These wide swings in demand indicate the difficulty in predicting future load growth using short term trends and the need rather to make predictions based on long term historical load growth rates together with customer surveys.

Toronto Hydro has conducted extensive surveys of residential and commercial-industrial customers in an attempt to track attitudes and intentions towards the use of electric

heating. While the popularity of electric heating will be influenced by the comparative prices of fossil fuels, our surveys indicate that electricity is perceived as a viable heating alternative (see Appendix page A17). Surveys of consumer attitudes towards different heating alternatives will be conducted annually, to enable Toronto Hydro to keep abreast of the effects of changing market conditions.

To determine the effect that electric heating additions could have on load growth, Toronto Hydro segregated the load into three categories - Residential, Commercial-Industrial and Supplementary. The Supplementary category includes residential locations where the primary heating energy used is fossil fuel, with electric heaters added as a supplementary heating source.

Survey results were not used directly to project load growth because of the inevitable time lag between the consumer's intentions and his actions and because of the necessarily short term time horizon of the survey. (i.e. Most customers would be uncertain about their intentions beyond a two to three year time frame.) However, the actual survey results are shown for comparison purposes in Appendix Figures 5 and 7.

Residential:

The 1981 National Energy Program forecasts that 10% of the home heating market will remain on oil in 1990. At present, 33% of Toronto Hydro's customers are heated by oil furnaces. Therefore, 23% will likely switch to either gas or electricity. Our own survey indicates a preference for electric heating in approximately 54% of the total population (see Appendix A17). However, after considering the survey data, Toronto Hydro requested additional input from its staff who work directly with customers, contractors and developers on a day-to-day basis. It was generally felt that an electric heating conversion rate of 54 per cent seemed high. We have considered that a degree of response bias toward electricity is likely to appear in a survey conducted by Toronto Hydro. In addition, the fact remains that natural gas is approximately 12 per cent cheaper than electricity at the retail level. Therefore we projected that up to 44 percent of off-oil conversions will be to electric heating systems. Using the above figures and a residential customer base of 120,000, this could result in approximately 12,200 new electric heating customers by 1990. Based on demand studies conducted by Toronto Hydro and other utilities, a figure of 10 kVA per customer is used to determine total load growth of 122,000 kVA by 1990. See Appendix Figure 5.

Commercial-Industrial:

Response to the Commercial-Industrial survey was not sufficient to provide statistically significant results. Therefore, Toronto Hydro assumes a very modest increase in electric heating applications in this sector. In order to track the effect on our load, Toronto Hydro made the following predictions, based on the customer survey.

The number of customers indicating an intention to convert to electric heating over the next few years were plotted on a graph. The graph was extrapolated to 1990. This gave us a prediction of the numbers of conversions each year. To convert these numbers to load growth, we proceeded as follows:

For those commercial-industrial customers with an existing demand under 25 kVA and intending to convert (890), an additional 15 kVA was allocated to electric heating. For customers with an existing demand of 25 to 100 kVA (185), 30 kVA of electric heating load was allocated. No significant conversions were indicated in the survey by customers with existing demands greater than 100 kVA.

A combination of the above figures, which are the numbers of customers converting multiplied by their expected additional load, results in a total additional load of 18,900 kVA by 1990, in the Commercial-Industrial sector. See Appendix Figure 6.

Supplementary Electric Heating

Supplementary electric heating could have a major impact on residential load growth in the next decade. Our survey results indicate that already more than 23 per cent or approximately 28,000 of our residential customers, use some electric heating to supplement their oil or gas furnaces. The nature of supplemental electric heating equipment is such that it is difficult for Toronto Hydro to determine the extent of this load. However, our survey tells us that customers will continue to add supplementary electric heaters. Therefore, a 1 per cent per year increase in the number of customers using supplementary electric heating, with an average of 2 kilowatts per customer has been predicted. This results in an additional load of approximately 22,500 kVA by 1990. See Appendix Figure 7.

Adding the additional load for each of the three categories outlined above results in a total load of approximately 163,400 kVA, or an annual growth rate of 3.5 per cent due to electric heating applications. (See Appendix Figure 8). However, as noted earlier, the expected impact of those electric heating conversions has been reduced to 2 per cent, with an additional 1.5 per cent due to historical growth patterns considered likely.

5. SOLUTIONS

The Toronto Electric Commissioners are committed to an energy conservation program targeted at all customer classes. Conservation education comprises the largest part of Toronto Hydro's promotion activities, and the utility initiates and participates in many conservation education projects. Customers contacting the utility for information about home heating are encouraged to participate in an on-site home energy survey. Toronto Hydro staff advise on the efficient use of energy and help customers find cost effective solutions to reduce energy costs.

Toronto Hydro is participating with other municipal utilities in co-operation with Ontario Hydro in load management experiments. Volunteer residential customers in the Metro area are equipped with load management devices designed to shift electricity usage into off-peak hours. Many types of electrical equipment are actually being managed or monitored in the test homes, including central electric furnaces; heat pumps; thermal electric storage furnaces; electric water heaters; air conditioners; clothes dryers; clothes washers; dishwashers; electric ranges; kitchen outlets; refrigerators and freezers. These experiments will provide valuable information about load management by direct control of customer loads.

Conservation and load management are regarded as important elements in Toronto Hydro's overall strategy to meet its customers' long range electrical energy requirements. We are presently conducting our own time-of-use rates experiments with a group of volunteer customers. Special digital demand recorders, which track how much electricity is consumed and at what time, have been installed at a group of homes across the City. Various time-of-use rates are being tested in these homes in an effort to determine consumer reaction to rate incentives. These experiments are providing Toronto Hydro with first-hand knowledge about the effects of time-of-use rates on residential load management.

Notwithstanding the above, the projected load growth requires that the utility act immediately to upgrade its distribution system. In reviewing the various solutions to accommodate load growth, Toronto Hydro's studies indicate that the 4 kV system should not be increased beyond present capacity, with minor exceptions, and that most of the load growth be accommodated through a new, higher voltage distribution system.

The 4 kV system, although having the capability to be expanded at the station level, has limitations at the distribution level. 4 kV is becoming an obsolete distributuion voltage in North America.

Due to the nature of electrical distribution, higher voltages tend to be more efficient means of transporting energy. For this reason most utilities have replaced, or are upgrading their 4 kV systems to higher voltages. This shrinking demand for 4 kV distribution equipment has resulted in a reduction in the availability of equipment.

Therefore, Toronto Hydro is meeting increasing electrical demand on the 4 kV overhead system by shifting load to 13.8 KV overhead plant. The 13.8 kV system is the most attractive alternative to Toronto Hydro because of the ready accessibility of supply and because of the availability of equipment and operational expertise.

While Toronto Hydro is proposing to install a primarily overhead 13.8 kV system in areas presently served by a 4 kV overhead system, various combinations of overhead and underground, or even an entirely underground distribution system, are feasible. However, labour and material costs for total underground construction can be as much as six times the cost of overhead construction.

6. Projected Capital Costs

The projected capital costs to carry out the work as outlined in Section 5 during the period 1984 to 1990 are shown in Appendix figure 4. These costs were determined as follows:

In 1984, for example, at 3.5 per cent load growth, the incremental load will be 19,600 kVA. By estimating the costs of conversion of specific trial locations, a cost per kVA was determined. This cost is estimated to be $389. By multiplying the cost per kVA by the total number of kVA's predicted for 1984, a total estimated capital requirement of $7.6 million results.

A similar calculation was prepared for subsequent years. It should be noted that, although the initial costs per KVA to establish a new distribution system are quite high, subsequent load growth within the newly established area could be accommodated at an incremental cost of $25. per kVA.

7. MANPOWER REQUIREMENTS

Toronto Hydro is analyzing manpower requirements based on the projected capital construction program. This analysis will identify manpower deficiencies, which will then be addressed.

Positive discussions have been held with CUPE Local 1, and it is expected that most of the work will be performed by Toronto Hydro employees. If necessary, contractors could be used to complement our own work force.

8. FINANCING

Capital requirements in excess of internally generated funds will have to be financed as part of the city's debenture base. Toronto Hydro will identify construction projects which are necessary to ensure reliability of electrical supply. These financing requirements will be determined annually by Toronto Hydro based on updated load growth information.

APPENDIX

FIGURE 1
PROJECTED TOTAL
4KV SYSTEM LOAD
AT GROWTH RATES
OF 1,3.5 AND 5%

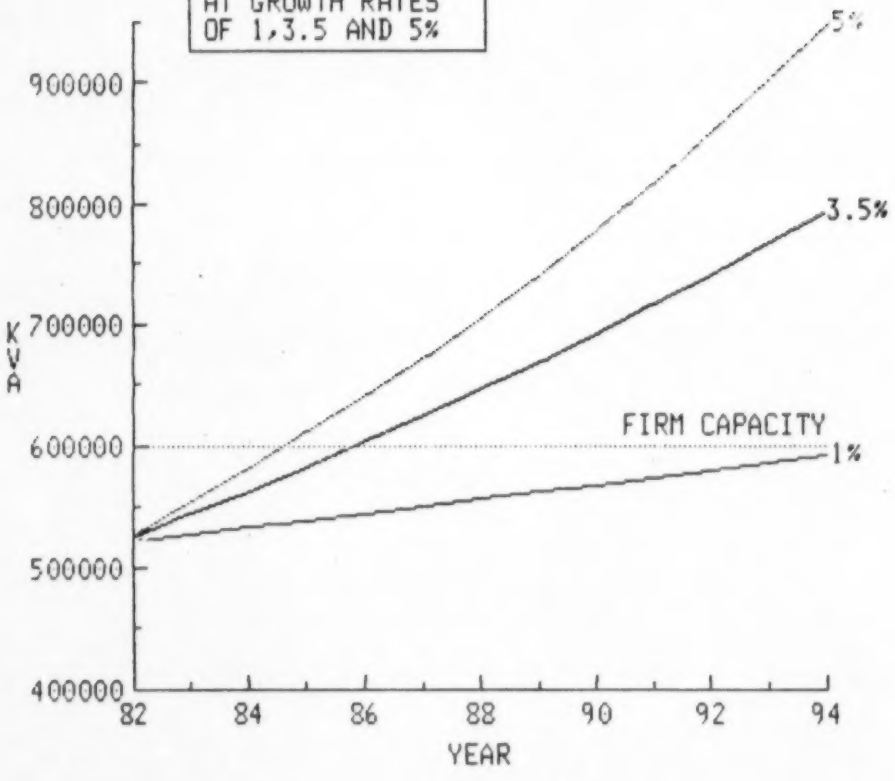
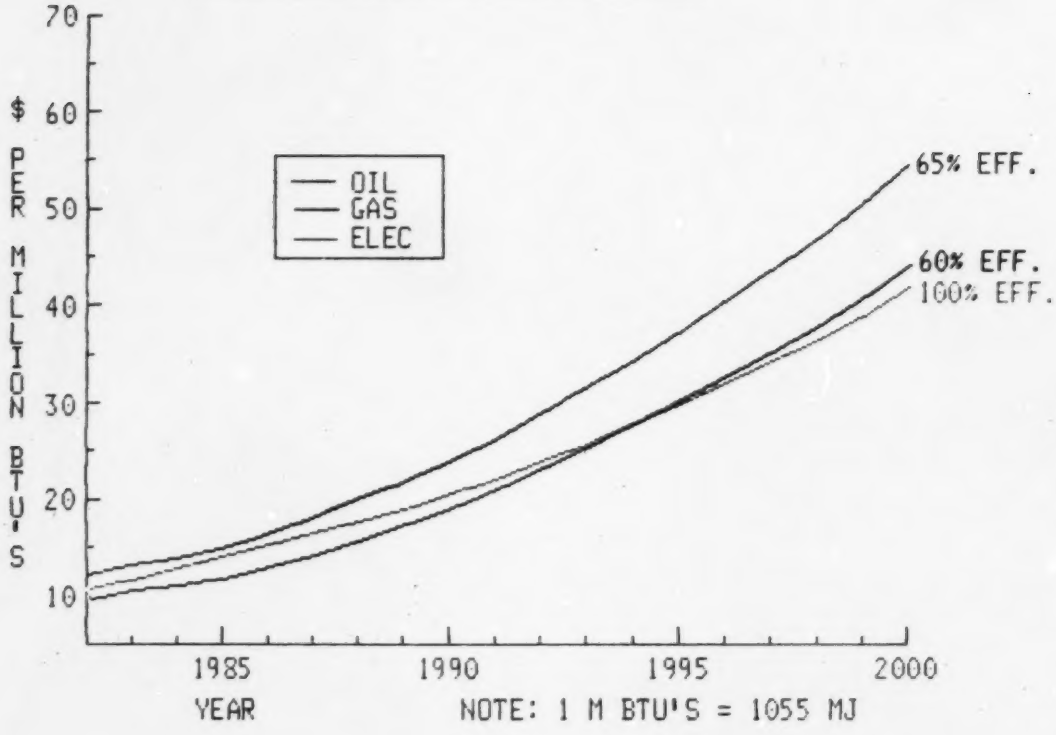


FIGURE 2 - 4kV STATION SUMMARY

STATION	FIRM CAPACITY (KVA)	80/81 PEAK (KVA)	LOAD GROWTH 80/81-81/82 (%)	81/82 PEAK (KVA)	LOAD GROWTH 81/82-82/83 (%)	82/83 PEAK (KVA)
CARLAW	43,100	38,200	+ 8.2	41,325	+ 4.3	43,100
CHAPLIN	16,700	14,600	+ 6.2	15,500	-17.4	12,800
COLLEGE	25,050	22,600	+ 4.9	23,700	+ 2.5	24,300
COMMISSIONERS	9,400	9,100	+ 4.4	9,500	+ 1.1	9,600
DANFORTH	25,050	20,800	+ 4.3	21,700	- 1.8	21,300
DEFOE	19,500	15,900	+ 8.2	17,200	- 6.4	16,100
DUFFERIN	16,700	12,000	+ 5.8	12,700	+ 0.8	12,800
DUPONT	25,050	22,000	- 0.5	22,550	- 5.1	21,400
EGLINTON	23,700	18,200	+ 6.6	19,400	- 8.2	17,800
FORMAN	8,350	5,800	+ 1.7	5,900	- 3.4	5,700
GEORGE & DUKE	18,800	16,400	+ 8.5	17,800	- 3.9	17,100
GLENGROVE	33,400	26,500	+ 7.5	28,500	- 1.1	28,200
HAMMERSMITH	25,050	20,600	+11.7	23,575	- 9.2	21,400
HAZELWOOD	25,050	19,300	+10.9	21,400	- 7.9	19,700
HIGH LEVEL	43,200	39,800	+ 4.8	40,000	- 2.3	39,100
JUNCTION	30,000	28,000	+ 4.6	27,835	- 5.9	26,200
KEELE & ST. CLAIR	14,700	10,300	+ 6.8	11,000	+ 7.3	11,800
KINGSWAY	3,750	1,900	- 5.3	1,800	+ 5.6	1,900
MERTON	16,700	13,800	+ 4.3	14,400	-11.1	12,800
MILLWOOD	8,350	4,300	0.0	4,300	--	4,300
ONTARIO	6,700	6,100	+ 3.3	6,300	+ 3.2	6,500
OVERDALE	7,750	4,300	+14.0	4,900	+18.4	5,800
PARKDALE	26,000	23,800	+ 8.0	25,000	- 3.6	24,100
QUEENSWAY	4,220	2,100	0.0	2,100	--	2,100
RENNIE PARK	7,500	3,800	+ 5.3	4,000	+ 2.5	4,100
RUNNYMEDE	16,700	13,700	+ 6.6	14,600	+ 2.1	14,900
SHERBOURNE	16,700	15,900	+10.0	17,535	-13.3	15,200
SPADINA	7,500	7,000	+12.9	7,900	-11.4	7,000
STRACHAN	16,700	11,200	+ 1.8	11,400	- 6.1	10,700
TERAULEY	9,400	7,200	- 8.3	6,600	- 7.6	6,100
UNIVERSITY	25,050	20,600	+15.5	23,800	- 9.3	21,600
WILTSHIRE	19,500	16,800	+ 4.2	17,500	- 1.1	17,300
TOTAL	595,320	493,900	+ 5.9	523,120	- 3.9	502,800 *

* Abnormal due to unusually mild winter

FIGURE 3
RETAIL COST PER MILLION BTU'S
BASED ON ONTARIO MINISTRY OF
ENERGY FORECASTS OF MARCH, 1983



PROJECTED CAPITAL COST FOR A 13.8 KV OVERHEAD DISTRIBUTION SYSTEM

Year	Load To Be Converted (KVA)	Est. Cost In 1983 Dollars	Escalated
1984	19,600	$7,600,000.00	$ 8,400,000.00
1985	20,300	7,900,000.00	9,600,000.00
1986	21,000	8,200,000.00	10,900,000.00
1987	21,700	8,400,000.00	12,300,000.00
1988	22,500	8,800,000.00	14,200,000.00
1989	23,300	9,100,000.00	16,100,000.00
		$50,000,000.00	$71,500,000.00

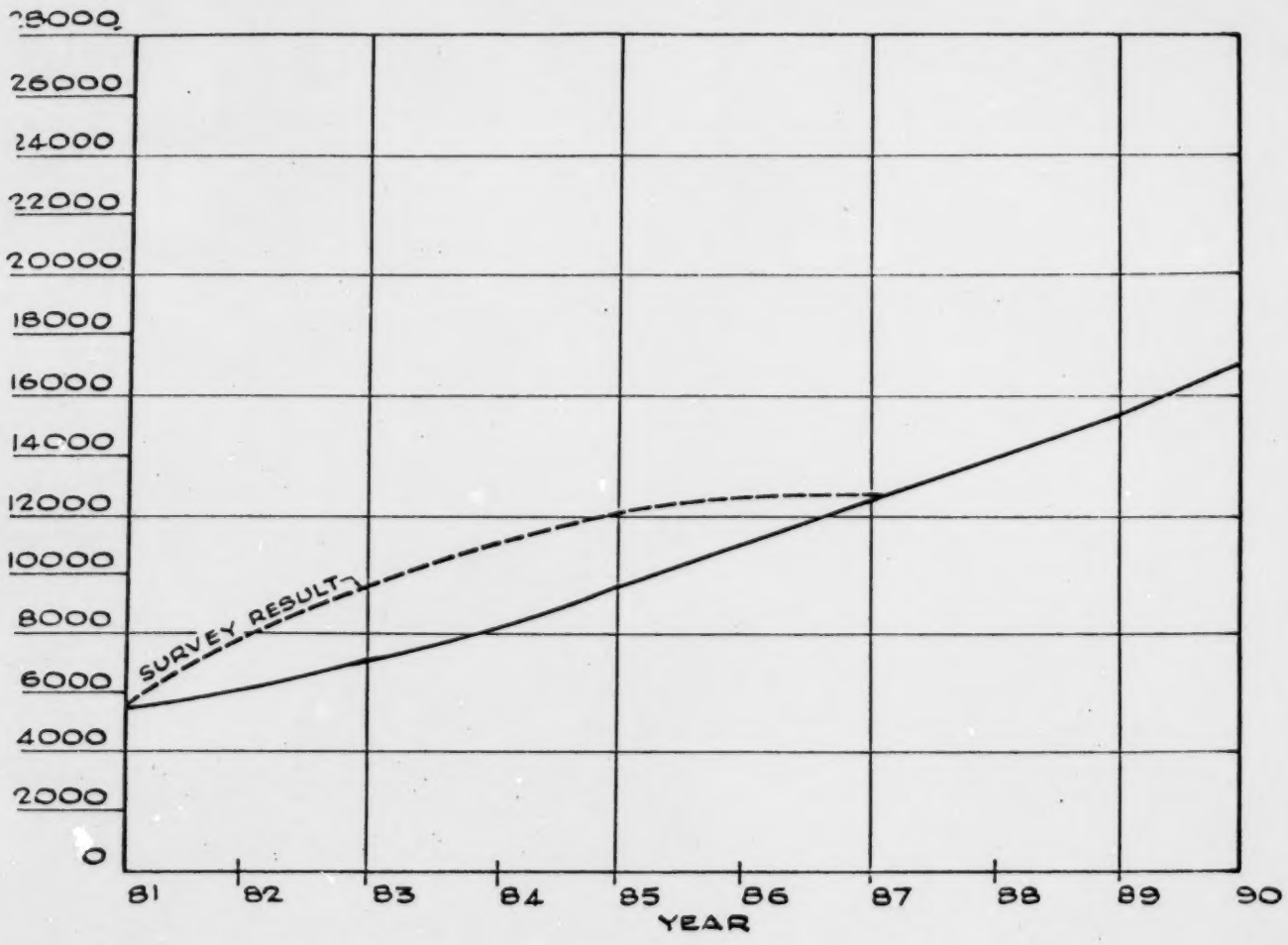
Note: (1) Estimated conversion cost per KVA - $389.

(2) The above costs are total capital costs of which 67% are applicable to labour.

(3) Escalation at 10% per annum.

FIGURE #4

PROJECTED NUMBER OF RESIDENTIAL ELECTRIC HEAT CUSTOMERS

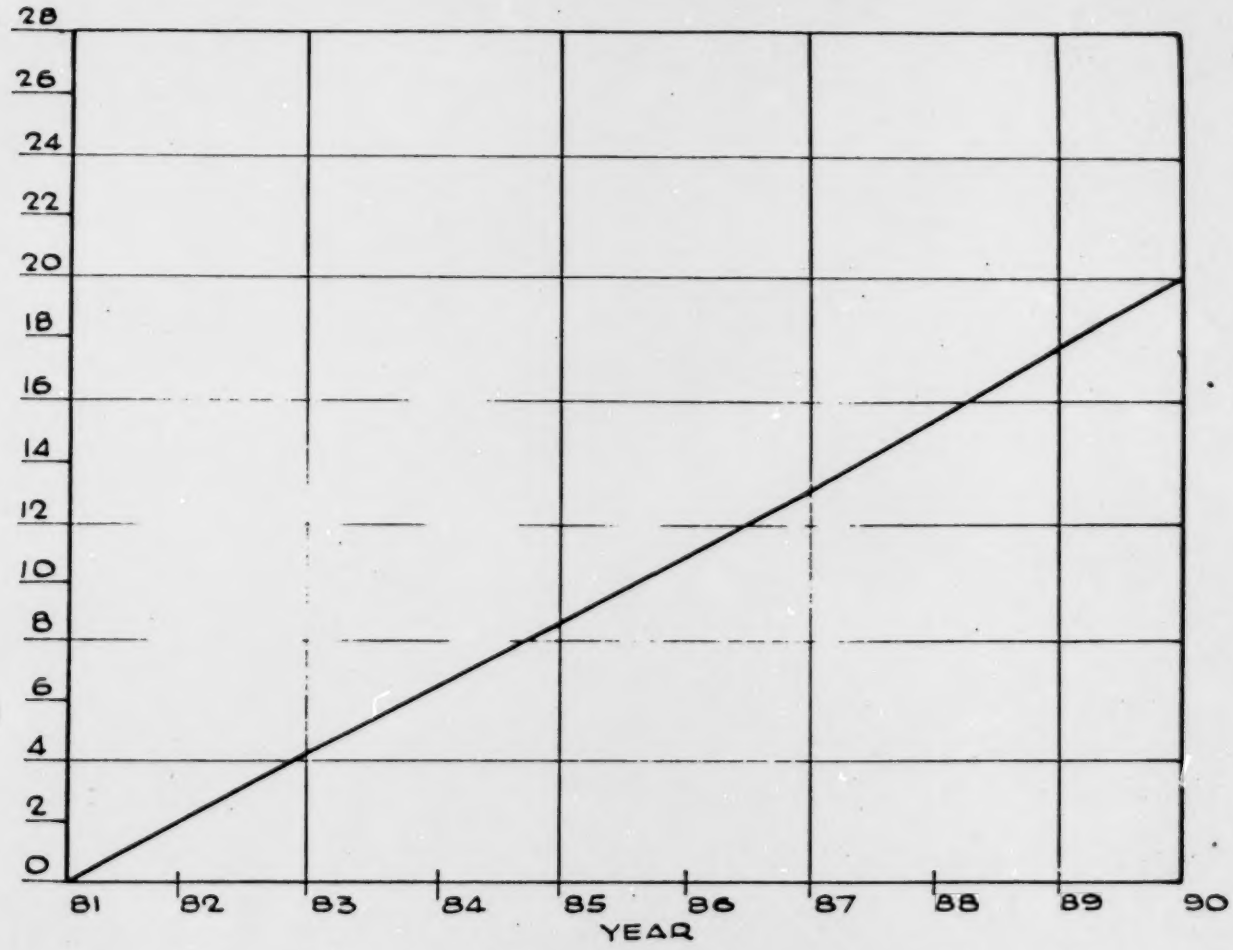


PROJECTED ANNUAL INCREASE IN LOAD DUE TO NEW RESIDENTIAL ELECTRIC HEAT CUSTOMERS

YEAR	82	83	84	85	86	87	88	89	90	TOTAL
MVA	10	10	12	15	15	15	15	15	15	122

FIGURE - 5

PROJECTED LOAD DUE TO CONVERSIONS TO ELECTRIC HEAT IN THE COMMERCIAL/INDUSTRIAL SECTOR



FIGURES BASED ON: 0-25 KVA CUSTOMERS USING 15 KVA

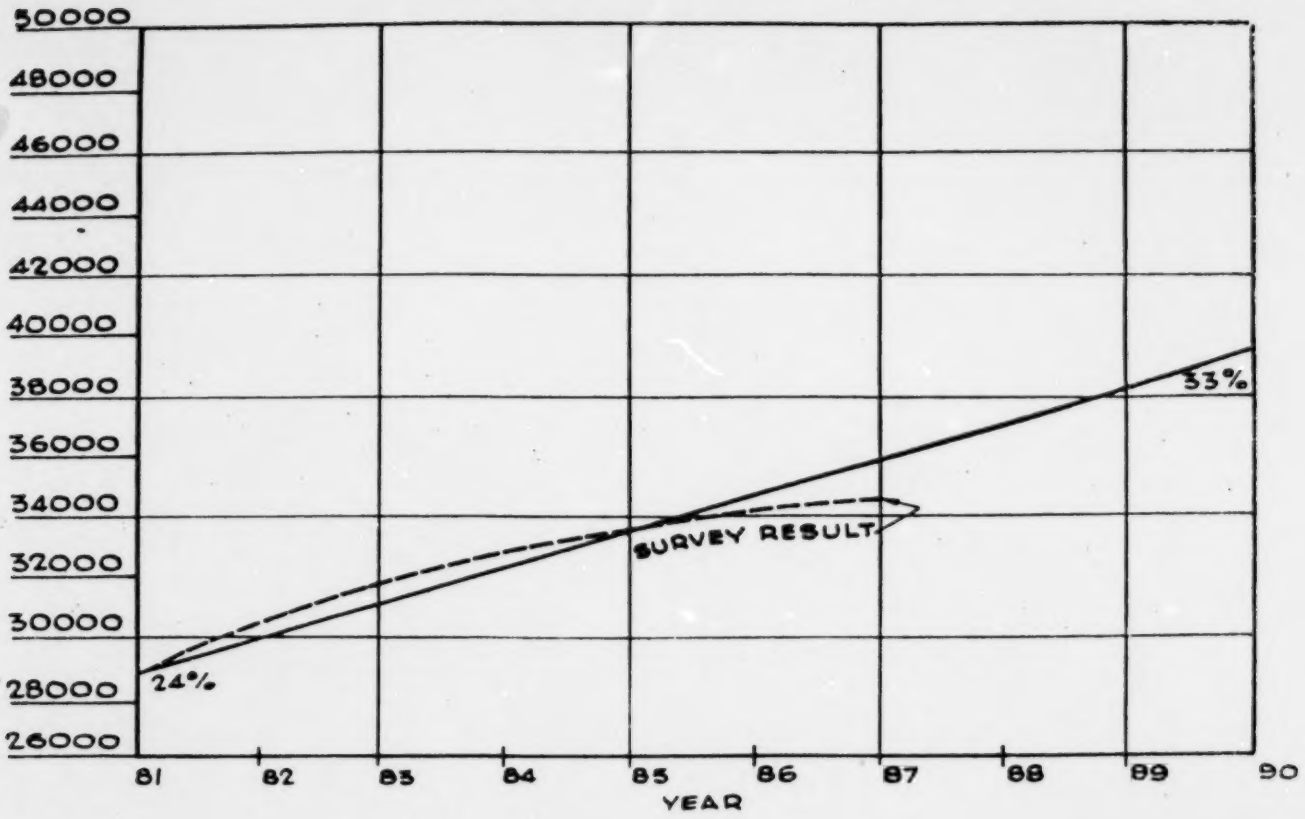
25-100 KVA CUSTOMERS USING 30 KVA

PROJECTED ANNUAL INCREASE IN LOAD DUE TO COMMERCIAL/INDUSTRIAL ELECTRIC HEAT CUSTOMERS.

YEAR	82	83	84	85	86	87	88	89	90	TOTAL
MVA	1·7	1·8	1·9	2·0	2·1	2·2	2·3	2·4	2·5	18·9

FIGURE - 6

PROJECTED NUMBER OF SUPPLEMENTARY ELECTRIC HEAT CUSTOMERS



PROJECTIONS BASED ON: 1% GROWTH PER YEAR

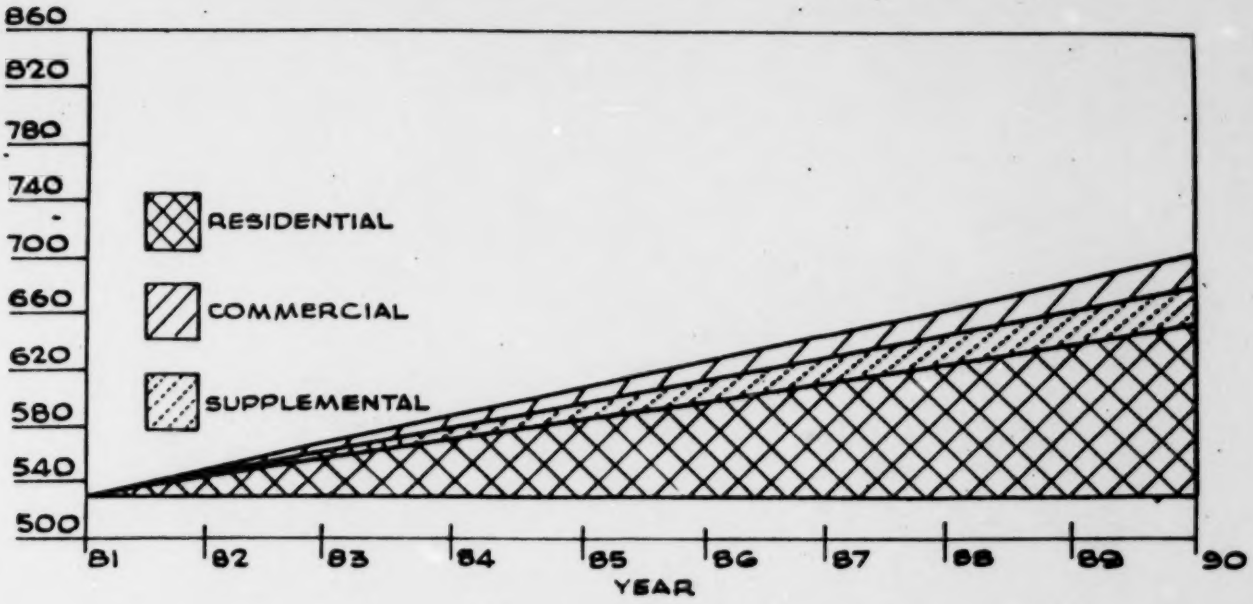
AVERAGE 2 KW PER CUSTOMER

PROJECTED ANNUAL INCREASE IN LOAD DUE TO SUPPLEMENTARY ELECTRIC HEAT

YEAR	82	83	84	85	86	87	88	89	90	TOTAL
MVA	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	22.5

FIGURE-7

PROJECTED TOTAL LOAD GROWTH DUE TO ELECTRIC HEATING



PROJECTED ANNUAL LOAD GROWTH

YEAR	82	83	84	85	86	87	88	89	90	TOTAL
MVA	14·2	14·3	16·4	19·5	19·6	19·7	19·8	19·9	20·0	163·4

FIGURE-8

STATISTICAL ANALYSIS

TORONTO HYDRO CUSTOMER INFORMATION SURVEY

The primary objectives of the customer survey were to determine the extent of electric heating on the distribution system and the potential for conversion from other heating systems to electric heating. The resulting loading effect on the distribution system was then to be determined.

The objectives of the survey itself, however, were to be viewed in the light of an on-going, long range effort to monitor and study load growth on the residential distribution system. Data gathered and the facilities set up for the survey are such that they can be built upon in future to meet long range plans and objectives.

Data requirements were first established. Toronto Hydro then proceeded to determine the means of gathering relevant information. Most of the billing-related customer information, such as monthly demand and consumption, was obtained directly from the Customer Information System Data Base (CIS D/B), but other necessary data was gathered through the survey, which provided information such as heating type, building characteristics and intention to convert to electric heating.

Data files were set up and computer programs developed to facilitate the selection of customers for the survey, gathering of relevant data and the study of data using statistical methods.

The information retained in the data files provides sufficient information for determining the extent of electric heating and the loading impact on the residential distribution system. The data file and the facilities set up for the survey also provide a base for future studies of a similar nature.

Basis of Survey

The focus of the survey was on the building, since, generally each building has one heating system, and the heating load could be conveniently related to building floor areas. This was particularly important for commercial buildings, as large differences in size makes it difficult to assign a "typical" heating load figure for a building, although time constraints did necessitate the utilization of a "typical" kW heating load value.

As a large number of buildings have multiple customer accounts, it was necessary to have one representative account for one single building (or

service address). This would effectively remove selection bias that would have occurred if all samples were simply drawn from the total available customer accounts. If samples were drawn directly from the customer base, buildings with more than one account would have a higher probability of being selected, which would then distort the results of the survey.

The first stage of the survey involved compressing the customer base so that each service address would be represented by only one account. The representative account would contain the totalized demand (undiversified) and consumption for all the accounts at the same address.

A history tape extracted from the CIS D/B was used as a base to produce the initial file which contained a representative account for each unique service address. The file was then used in the preliminary studies and for the selection of survey samples.

The Survey Samples

The total number of customers, each representing one building, was approximately 136,000. To facilitate the survey, the customers were divided into four groups:

a) large user or over 500 kW customers
b) small to medium user commercial/industrial customers
c) residential customers
d) test area customers

The over 500 kW customers were very large customers and had certain common characteristics. They were isolated and studied as a group. A customer was defined as over 500 kW if in any of the 12 months of billing history kW demand was more than 500 kW before compression.

The test area was an area supplied from a 4kV Feeder. Each customer was identified manually and tagged on the survey data file, so a saturation survey could be carried out. The test area was of special interest to the engineering group in regard to investigation of loading problems and the development of costing data for the design of a new distribution system.

Sample Selection and Response

The Residential Sector

The total residential sector, after compression, was made up of approximately 120,000 customer locations or buildings.

The sample that was sent out to the residential population was in the order of 21,000.

An analysis, which was based on a sample response of 7,669 customers yielded a percentage accuracy of approximately plus or minus 2.2% at the 95% confidence level. The confidence level of a sample refers to the probability that the inferences being made from the sample will be correct relative to the true, and unknown, state of the world. Thus, at a 95% confidence level, we can be certain that 95 times out of 100 statistical inferences being made will be correct.

The Commercial Sector

The small to medium user commercial/industrial sector consists of approximately 16,000 buildings which includes both inactive and active accounts. Two pilot

studies were run, and the results led to the conclusion that it would be best to do a complete census of the small to medium user commercial sector. A saturation sample of the commercial sector was conducted and was made up of 15,648 active customer building locations.

The Over 500 kW Group

The Over 500 kW Group is made up of 421 active and 13 inactive accounts for a total of 434 accounts. In this case a compression of accounts to buildings was not done prior to the mailing of the sample. Due to the size of the customer load, it was felt that each location would have its own load characteristics and heating needs. An initial customer enquiry was conducted to determine the best person in the organization to send the form to, and to determine how many forms the customers would need to satisfy our survey requirements. In some cases questionnaires were not required for all of the customer's locations and the number of questionnaires sent out was reduced to 382. A mail and telephone follow-up to those customers who had not replied after a one month period was also conducted.

In all, 251 large user customers responded to the questionnaire for a response rate of approximately 65.7%. The sample is accurate to within plus or minus 7.2% at the 95% confidence level.

The Test Area

For the commercial portion of the test area there were 67 customers who were included in the initial saturation mailing. Subsequently, a mail follow-up of 60 commercial customers took place. Total response in the commercial sector was 24 customers for a response rate of approximately 35.8%. Because of the very small sample size the accuracy of the sample is relatively low at approximately 32% at the 95% confidence level.

The regular mailing for the residential portion of the test area sample consisted of approximately 100 customers. The second mailing for the test area after taking into account the regular mailing was 599 customers, for a total residential test area sample of 699 customers. The mail follow-up in this case was relatively large with 506 letter follow-ups being sent out.

The response to the questionnaire in the residential portion of the test area was very high with 428 customers replying for a response rate of approximately 61.2%. The result is accurate to within plus or minus 5.9% at the 95% confidence level.

Sample Observations

In this section base data that was utilized in developing the forecast of the impact of electric heat on the distribution system is provided.

The Residential Sector

The survey revealed that as of February, 1982, current heating energy saturations excluding apartments in the Toronto Hydro service area were 4.4% electric heating, 32.9% oil heating and 62.3% gas heating. Further, approximately 23.3% of the survey population use supplementary electric heating, i.e. plug in type or auxiliary baseboard heating with an average size of approximately 2 kW.

The survey indicates that 16.3% of the population are planning some form of heating energy conversion. Of those planning a conversion, 45.9% indicate that they

will convert to gas heating while 41.6% say they will convert to electricity. In addition, 54% of the total survey population indicated that they would switch to electricity if they were to convert.

A few interesting facts resolved from cross tabulations were as follows:

1. In the past 5 years, one in every three customers who converted to electric heating was previously heating with gas.
2. Of the customers stating they were converting to electric heating in the next 5 years, one in every three are heating with gas at present.
3. A large percentage of existing oil and gas furnaces are nearing the end of their life cycle.
4. Many customers have installed 200 amp. services but at present do not heat electrically.
5. Approximately 25% of our residential customers have some form of supplementary electric heating.

The Commercial Sector and Over 500 kW Group

The commercial sector was broken down into 4 kilowatt load groups for customer and load analysis purposes as follows:

- less than 25.0 kW maximum Winter demand.
- 25.1 to 100.0 kW maximum Winter demand.
- 100.1 to 500.0 kW maximum Winter demand.
- greater than 500.0 kW maximum Winter demand.

The over 500 kW customers in the small to medium user Commercial/Industrial sector sample were those customers that after compression had a combined, non-diversified load over 500 kW.

By breaking the commercial sector into smaller load groups it was determined that there was little if any conversion activity occuring for customers who have loads in excess of 100 kW. Therefore these customers were not factored into the forecast and instead, attention was focused on customers with smaller loads whom it was felt would be on the 4kV distribution system where loading problems will be occuring.

The under 25 kW customer population is in the order of 12,125 customers and the number of respondents was 1,597. The heating energy saturations are 14.4% electric, 45.3% gas, 37.3% oil while 3.0% of the respondents use another source such as steam heating. About 4.1% of the respondents indicated their intention to convert to electric heating. This implies that approximately 500 customers wll be converting in the next three to four years. Extrapolated to 1990, 890 customers will convert to electric heating. The source of conversions heavily favours oil with 6.7% of the oil heating population indicating

an intention to convert to electric heating. In the gas heating sector only 3.6% of the population intend to convert to electricity.

For the next largest load group, 25 to 100 kW, the total population is in the order of 2,935 customers from which 560 questionnaires were received. Gas heating again has the highest saturation at approximately 55.4% with oil next at 23.6% electricity at 18.2% and other heating sources accounting for 2.9%.

For this load group 3.4% indicated their intention to convert to electric energy which would imply an additional 100 electric heating customers in the next three to four years. Extrapolated to 1990, this represents 185 conversions. Customers converting off-oil are the largest source of conversions with 7.6% converting to electricity. Gas customers are not converting as rapidly but there is an indication that 2.9% will convert to electricity.

The 100 to 500 kW group has a total population of 1,187 buildings and 252 questionnaires were received from them. It appears that as the size of the load increases there is a

tendency towards the use of gas heating as this group has a gas heating saturation of 62.3% whereas oil is used by 13.9% of the respondents, electricity by 15.5% and other fuels by 8.3%. Conversions are not extensive with only 2 customers or 0.8% of the respondents indicating their intention to convert to electric heating.

The Over 500 kW Group has an existing oil heating saturation of 7.6%, gas heating of 58.2%, electric heating of 21.1% and other heating sources of 13.1%. Within this large user customer group, 4 customers out of the 251 that responded indicated their intention to convert to electric heating although our records show that one customer will simply be upgrading his existing electric heating system.